

# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-124568

(43)Date of publication of application : 26.04.2002

(51)Int.Cl.

H01L 21/768  
H01L 21/3065

(21)Application number : 2000-317661

(71)Applicant : TOKYO ELECTRON LTD

(22)Date of filing : 18.10.2000

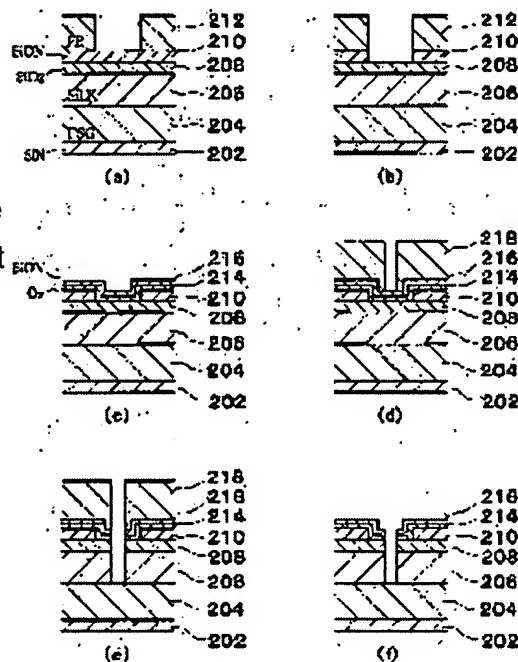
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## (54) METHOD FOR ETCHING DUAL DAMASCENE STRUCTURE

### (57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for etching a dual damascene structure in which shoulder dropping of a hard mask can be suppressed.

SOLUTION: In the method for etching a dual damascene structure employing at least one layer of Lowk film and at least one layer of hard mask, at least one dummy layer which is not left finally in the structure is formed on the hard mask in order to prevent shoulder dropping.



## LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the etching approach of a dual pellet syn conformation.

[0002]

[Description of the Prior Art] In recent years, the manufacturing technology of a semiconductor device which has multilayer structure is quickly developed with high integration of a semiconductor integrated circuit. In the case of the semiconductor device which has multilayer structure, it is necessary to form beer hall wiring which connects each component developed perpendicularly with trench wiring which connects each component developed horizontally. In that case, in order to attain improvement in the speed of an integrated circuit, recently as a wiring material, the copper which was excellent in electromigration resistance with low resistance is used. As a layer insulation ingredient, there are organic LowK ingredients, such as SiLKTM (U.S. Dow Chemical Co. product) which can secure a low dielectric constant. Moreover, the fluoridation oxidation silicon film (the FSG film is called hereafter) of a low dielectric constant which is an inorganic LowK ingredient is also used.

[0003] In addition, in case a circuit pattern is formed with the copper which cannot form a compound with high vapor pressure easily, the so-called pellet syn conformation which performs wiring embedding using a metal CMP technique is adopted. Furthermore, the so-called semiconductor device of the dual pellet syn conformation which makes from recently beer wiring which connects each component developed perpendicularly with trench wiring which connects each component developed horizontally to coincidence, and is crowded is spreading. In case this dual pellet syn conformation is made and it is crowded, pattern formation of the hard surface mask blank is carried out, an insulating layer is etched using this hard surface mask blank, and a trench and beer are formed.

[0004]

[Problem(s) to be Solved by the Invention] An example of the process which forms the conventional dual pellet syn conformation in drawing 7 and drawing 8 is shown. As shown in drawing 7 (a), in the upper part of the SiN layer 2 as a protective coat, as inorganic LowK film which constitutes a layer insulation membrane layer The \*\* FSG layer 4 and on it, as the SiLKTM layer 6 as organic LowK film, and a hard surface mask blank layer for forming a trench and beer further \*\*\*\* -- one -- a hard surface mask blank -- it is -- a place -- SiO -- two-layer -- eight -- and -- the -- two -- a hard surface mask blank - - it is -- a place -- SiON -- a layer -- ten -- and -- a trench -- formation -- \*\* -- a pattern -- a configuration -- having -- a photoresist -- (-- PR --) -- a layer -- 12 -- forming -- having -- \*\*\*\* .

[0005] First, as shown in drawing 7 (b), using the photoresist (PR) layer 12 for trenches, according to a predetermined lithography process, the SiON layer 10 which is the 2nd hard surface mask blank is etched, and a trench pattern is formed. And as shown in drawing 7 (c), the photoresist (PR) layer 14 for beer formation is formed.

[0006] next, the SiO two-layer which is the 1st hard surface mask blank by the predetermined lithography process using the photoresist (PR) layer 14 for beer as shown in drawing 7 (d) -- 8 is etched and a beer pattern is formed.

[0007] And as shown in drawing 7 (e), while etching beer into the SiLKTM layer 6 which is the organic LowK film using the hard surface mask blank for beer formed at the last process, ashing of the photoresist (PR) layer 14 is carried out, and it is removed.

[0008] next, the SiO two-layer which is the 1st hard surface mask blank using the trench pattern of the SiON layer 10 which is the 2nd hard surface mask blank as shown in drawing 7 (f) -- beer is formed in the FSG layer 4 as a beer pattern using the beer which formed the trench pattern in 8 and was further formed in the SiLKTM layer 6.

[0009] next, the SiO two-layer which is the 1st hard surface mask blank as shown in drawing 8 (a) -- a trench pattern is formed in the SiLKTM layer 6 using the trench pattern of the SiON layer 10 which are 8 and the 2nd hard surface mask blank.

[0010] Next, the SiN layer 2 is etched and beer is made to penetrate using the beer pattern of the FSG layer 4, as shown in drawing 8 (b). The dual pellet syn conformation which builds a trench and beer to coincidence as mentioned above, and is crowded is completed. Furthermore, a wiring process is completed by embedding the metal containing non-illustrated Cu or Cu from a trench and beer.

[0011] However, it was easy to produce the so-called shoulder omission which can delete the part of the shoulder of a hard surface mask blank, and becomes slanting in the process explained above at the process which a hard surface mask blank exposes. for example, the SiO two-layer of the 1st hard surface mask blank exposed by over etching at the process shown in drawing 7 (f) after removing the photoresist (PR) layer 14 -- shoulder omission as shown in 8 and the SiON layer 10 of the 2nd hard surface mask blank at drawing 9 arises.

[0012] Among these, the shoulder omission produced in the SiON layer 10 of the 2nd hard surface mask blank is in the inclination which is not improved at a back process and gets worse further by etching at a back process. When shoulder omission arose in the hard surface mask blank, the exaggerated polish (dishing) occurred in the dense part of a pattern in back processes, such as CMP, and there was a trouble of becoming the cause of wiring short-circuit.

[0013] This invention is made in view of the above-mentioned trouble, and aims at offering the etching approach of the dual pellet syn conformation which can control the shoulder omission of a hard surface mask blank.

[0014]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, according to this invention, like a publication to claim 1 In order to be the etching approach of a dual pellet syn conformation using the LowK film of at least one or more layers, and the hard surface mask blank of at least one or more layers and to prevent :shoulder omission The etching approach of the dual pellet syn conformation characterized by forming at least one or more layers of dummy film which finally does not remain into structure on said hard surface mask blank is offered. According to this configuration, if it is the former, in the process which a hard surface mask blank exposes, the shoulder omission of a hard surface mask blank can be controlled by this invention by exposing the dummy film instead of a hard surface mask blank, and considering as a protective coat. Since this dummy film finally does not remain, it does not influence formation structure.

[0015] The bottom may be the inorganic LowK film and you may make it for a thing [ said LowK film being formed by two kinds of film, and etching by respectively different gas like, in that case, ] according to claim 2 to be desirable, and the bottom of said LowK film be the organic LowK film like the publication to claim 3. As inorganic LowK film, FSG can be used, for example and SiLKTM can be used as organic LowK film, for example.

[0016] Moreover, the number of said hard surface mask blanks may be one like the publication to claim 4, or they may be two-layer like the publication to claim 5. In that case, a thing [ that at least one layer of said hard surface mask blank contains SiON ] according to claim 6 is [ like ] desirable. Since SiON works also as an antireflection film, it is effective in a dimension being stabilized in the case of lithography. Said dummy film may be carried out as [ include / like a publication / in claim 7 / the film of the same ingredient as said hard surface mask blank ], and is good for claim 8 also as SiON like a publication.

[0017] According to another viewpoint of this invention, the inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer like, and the 1st hard surface mask blank according to claim 9, and the 2nd hard surface mask blank are set as the etched object. the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer -- it is -- : -- according to a lithography process to the 2nd hard surface mask blank To said 3rd hard surface mask blank and said 1st hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 3rd hard surface mask blank to the trench pattern which consists of the 2nd hard surface mask blank of; above; according to a lithography process The 3rd process which forms a beer pattern; with the beer pattern which consists of said 3rd hard surface mask blank and said 1st hard surface mask blank The 4th process which forms beer in the organic LowK film, and the 5th process which removes a part of 3rd hard surface mask blank layer [ at least ] of; above; according to the same etching conditions, while removing the remainder of said 3rd hard surface mask blank layer The beer which formed the trench pattern in said 1st hard surface mask blank with the trench pattern which consists of said 2nd hard surface mask blank, and was further formed in said organic LowK film is used as a beer pattern. The 6th process which uses and forms beer in said inorganic LowK film; the etching approach of the dual pellet syn conformation characterized by consisting of the 7th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st and 2nd hard surface mask blanks, and; is offered. According to this configuration, in the process which the 3rd hard surface mask blank exposes, even if shoulder omission arises in the 3rd hard surface mask blank, a part of 3rd hard surface mask blank can be removed, and a hard surface mask blank without shoulder omission can be expressed again. Moreover, since the 3rd hard surface mask blank works as a protective coat, the shoulder omission of the 2nd hard surface mask blank can be controlled.

[0018] Like the publication to claim 10 in that case, said 3rd hard surface mask blank has two or more layer structure, and its thing [ that the upper layer of the 3rd hard surface mask blank is removed, and the lower layer of the 3rd hard surface mask blank is removed in said 6th process in said 5th process like ] according to claim 11 is desirable. In addition, the upper layer of said 3rd hard surface mask blank consists of SiON, and you may make it a lower layer change from Ox to claim 12 like a publication. Since SiON works also as an antireflection film, it is effective in a dimension being stabilized in the case of lithography.

[0019] Moreover, according to another viewpoint of this invention, the inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer like, and the 1st hard surface mask blank according to claim 13, and the 2nd hard surface mask blank are set as the etched object. the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer -- it is -- : -- according to a lithography process to the 2nd hard surface mask blank To said 3rd hard surface mask blank and said 1st hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 3rd hard surface mask blank to the trench pattern which consists of the 2nd hard surface mask blank of; above; according to a lithography process The 4th process which forms beer in the organic LowK film with the beer pattern which consists of the 3rd process which forms a beer pattern, the 3rd hard surface mask blank of; above, and said 1st hard surface mask blank; according to the same etching conditions While removing said 3rd hard surface mask blank layer, with the trench pattern which consists of said 2nd hard surface mask blank The beer which formed the trench pattern in said 1st hard surface mask blank, and was further formed in said organic LowK film is used as a beer pattern. The 5th process which uses and forms beer in said inorganic LowK film; the etching approach of the dual pellet syn conformation characterized by consisting of the 6th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st and 2nd hard surface mask blanks, and; is offered. Like the publication to claim 14 in that case, said 3rd hard surface mask blank may be constituted as it has two or more layer structure.

[0020] Moreover, according to another viewpoint of this invention, the inorganic LowK film and the organic LowK film according to claim 15 by which the laminating was carried out one by one on the

lower layer wiring layer like, and the 1st hard surface mask blank are set as the etched object. It is the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer. To a part of 1st hard surface mask blank of :above according to a lithography process To the residual part of said 1st hard surface mask blank, and the 2nd hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 2nd hard surface mask blank to the trench pattern of the 1st hard surface mask blank of; above; according to a lithography process The 3rd process which forms a beer pattern, and the 4th process which forms beer in said organic LowK film with the beer pattern which consists of the 1st and 2nd hard surface mask blanks of; above; while removing said 2nd hard surface mask blank The 5th process which etches the trench pattern part of said 1st hard surface mask blank, and forms a trench pattern; The beer formed in said organic LowK film is used as a beer pattern. The 6th process which uses and forms beer in said inorganic LowK film; the etching approach of the dual pellet syn conformation characterized by consisting of the 7th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st hard surface mask blank, and; is offered. Since according to this configuration the 2nd hard surface mask blank can be removed, a hard surface mask blank without shoulder omission can be expressed again and the 2nd hard surface mask blank works as a protective coat in the process which the 2nd hard surface mask blank exposes even if shoulder omission arises in the 2nd hard surface mask blank, the shoulder omission of the 1st hard surface mask blank can be controlled.

[0021] According to another viewpoint of this invention, further again like a publication to claim 16 The inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer, and the 1st hard surface mask blank are set as the etched object. It is the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer. To a part of 1st hard surface mask blank of :above according to a lithography process To the residual part of said 1st hard surface mask blank, and the 2nd hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 2nd hard surface mask blank to the trench pattern of the 1st hard surface mask blank of; above; according to a lithography process The 3rd process which forms a beer pattern; with the beer pattern which consists of said 1st and 2nd hard surface mask blanks The 4th process which forms beer in said organic LowK film; The beer formed in said organic LowK film is used as a beer pattern. The 5th process which uses and forms beer in said inorganic LowK film, and the 6th process which removes the 2nd hard surface mask blank of; above; The trench pattern part of said 1st hard surface mask blank is etched. The 7th process which forms a trench pattern; the etching approach of the dual pellet syn conformation characterized by consisting of the 8th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st hard surface mask blank, and; is offered.

[0022] In that case, a thing [ that said 1st and 2nd hard surface mask blanks consist of the same ingredient ] according to claim 17 is [ like ] desirable. Since according to this configuration it is again covered by the 2nd hard surface mask blank of the same ingredient even if over etching of the part is carried out and the organic LowK film is exposed, in case a part of 1st hard surface mask blank is etched, there is an advantage that mixing does not arise. In addition, the thing [ that it is SiON ] according to claim 18 of said ingredient is [ like ] desirable. Since SiON works also as an antireflection film, it is effective in a dimension being stabilized in the case of lithography.

[0023]

[Embodiment of the Invention] Below, the suitable operation gestalt of the etching approach concerning this invention is explained, referring to an accompanying drawing. In addition, in the following explanation and an accompanying drawing, duplication explanation will be omitted by \*\*\*\*\* which attaches the same sign about the member which has the functional configuration of abbreviation identitas.

[0024] First, the outline configuration of the plasma etching system of an parallel monotonous mold is explained as an example of the etching system for enforcing the etching approach concerning the gestalt

of this operation, referring to drawing 1 .

[0025] The processing room 104 is formed in the processing container 102 with which security touch-down of the etching system 100 shown in this drawing was carried out, and the lower electrode 106 which constitutes the susceptor which can move up and down freely is arranged in this processing room 104. The electrostatic chuck 110 connected to the high voltage direct current power source 108 is formed in the upper part of the lower electrode 106, and the processed object (a wafer is called hereafter) W, for example, a semi-conductor wafer, is laid in the top face of this electrostatic chuck 110. Furthermore, the focal insulating ring 112 is arranged around the wafer W laid on the lower electrode 106. Moreover, RF generator 120 is connected to the lower electrode 106 through the adjustment machine 118.

[0026] Moreover, the up electrode 122 equipped with much gas discharge opening 122a is arranged at the head-lining section of the installation side of the lower electrode 106, and the processing room 104 which counters. An insulator 123 is infixed between the up electrode 122 and the processing container 102, and it insulates electrically. Moreover, RF generator 121 which outputs plasma production high-frequency power through the adjustment machine 119 is connected to the up electrode 122. Moreover, a gas supply line 124 is connected to gas discharge opening 122a, and the process gas supply system 126 is further connected to the gas supply line 124. The source 136 of gas supply which supplies process gas through the closing motion bulb 132 and a positive crankcase ventilation valve 134 is connected to the process gas supply system 126.

[0027] Moreover, under the processing container 102, the vacuum suction device in which it does not illustrate, and the exhaust pipe 150 open for free passage are connected, and the inside of the processing room 104 can be maintained in a predetermined reduced pressure ambient atmosphere by actuation of the vacuum suction device.

[0028] Next, the process which forms the dual pellet syn conformation concerning the gestalt of operation of the 1st of this invention is explained using the above-mentioned etching system, referring to drawing 2 and drawing 3 . The FSG layer 204 (500nm of thickness) as inorganic LowK film which constitutes a layer insulation membrane layer in the upper part of the SiN layer 202 (50nm of thickness) as a protective coat as shown in drawing 2 (a), On it, the SiLKTM layer 206 (400nm of thickness) as organic LowK film, the SiO two-layer which is the 1st hard surface mask blank as a hard surface mask blank layer for furthermore forming a trench and beer -- the SiON layer 210 (100nm of thickness) which are 208 (100nm of thickness), and the 2nd hard surface mask blank -- And the photoresist (PR) layer 212 which has a pattern configuration for trench formation is formed.

[0029] First, as shown in drawing 2 (b) (the 1st process), using the photoresist (PR) layer 212 for trenches, according to a predetermined lithography process, the SiON layer 210 which is the 2nd hard surface mask blank is etched, and a trench pattern is formed. As etching conditions at this time, the flow rate of 500W, mixed-gas CH<sub>2</sub>F<sub>2</sub>, and O<sub>2</sub> and Ar is set to 20sccm(s), 20sccm, and 100sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 50mT(s) and an electrode, respectively, for example.

[0030] After carrying out ashing of the residual photoresist (PR) layer 212 and removing it, as shown in drawing 2 (c) (the 2nd process), the 3rd hard surface mask blank is covered to the trench pattern which consists of the 2nd hard surface mask blank. With the gestalt of this operation, the 3rd hard surface mask blank is a thin film which consists of two-layer [ of the lower layer Oxide layer 214 (less than 10nm of thickness), and the upper SiON layer 216 (less than 10nm of thickness) ]. Here, although the Oxide layer 214 and the SiON layer 216 can be formed by CVD (Chemical Vapor Deposition), it can also form with a spin coat. In the case of a spin coat, it can form by applying inorganic [ with very low viscosity / SOG ] by about 5000 rpm, and making it harden at 400 degrees C. Furthermore, as shown in drawing 2 (d), the photoresist (PR) layer 218 for beer formation is formed on it.

[0031] next, the SiO two-layer which is the Oxide layer 214, the SiON layer 216, and the 1st hard surface mask blank which are the 3rd hard surface mask blank by the predetermined lithography process using the photoresist (PR) layer 218 for beer as shown in drawing 2 (e) (the 3rd process) -- 208 is etched and a beer pattern is formed. As etching conditions at this time, the flow rate of 1500W and mixed gas

CF<sub>4</sub>, O<sub>2</sub>, and Ar is set to 80sccm(s), 20sccm, and 160sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 40mT(s) and an electrode, respectively, for example.

[0032] And as shown in drawing 2 (f) (the 4th process), while etching beer into the SiLKTM layer 206 which is the organic LowK film using the hard surface mask blank for beer which consists of the 3rd hard surface mask blank and the 1st hard surface mask blank which were formed at the 3rd process, ashing of the photoresist (PR) layer 218 is carried out, and it is removed. As etching conditions at this time, the flow rate of 1000W and mixed gas N<sub>2</sub> and H<sub>2</sub> is set to 100sccm(s) and 300sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 100mT(s) and an electrode, respectively, for example. In this case, after the photoresist (PR) layer 218 is removed, shoulder omission may arise in the 3rd exposed hard surface mask blank by over etching.

[0033] Then, as shown in drawing 3 (a) (the 5th process), the SiON layer 216 which is the upper layer of the 3rd hard surface mask blank which shoulder omission has produced is removed by isotropic etching. By this etching, the conditions from which energy of ion is made as small as possible, and a high selection ratio is obtained to SiO<sub>2</sub>, or wet etching is chosen. Even after removing the upper SiON layer 216, since the lower layer Oxide layer 214 remains, it can express again the 3rd hard surface mask blank without shoulder omission.

[0034] next, the SiO two-layer which is the 1st hard surface mask blank using the trench pattern of the SiON layer 210 which is the 2nd hard surface mask blank while removing the Oxide layer 214 which is a lower layer of the 3rd hard surface mask blank on the same etching conditions, as shown in drawing 3 (b) (the 6th process) -- beer is formed in the FSG layer 204 as a beer pattern using the beer which formed the trench pattern in 208 and was further formed in the SiLKTM layer 206. As etching conditions at this time, the flow rate of 1500W, mixed-gas C<sub>4</sub>F<sub>8</sub>, and CO and Ar is set to 12sccm(s), 225sccm, and 400sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 45mT(s) and an electrode, respectively, for example.

[0035] next, the SiO two-layer which is the 1st hard surface mask blank as shown in drawing 3 (c) (the 7th process) -- a trench pattern is formed in the SiLKTM layer 206 using the trench pattern of the SiON layer 210 which are 208 and the 2nd hard surface mask blank.

[0036] Next, the SiN layer 202 is etched and beer is made to penetrate using the beer pattern of the FSG layer 204, as shown in drawing 3 (d). As etching conditions at this time, the flow rate of 500W, mixed-gas CH<sub>2</sub>F<sub>2</sub>, and O<sub>2</sub> and Ar is set to 20sccm(s), 20sccm, and 100sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 30mT(s) and an electrode, respectively, for example. The dual pellet syn conformation which builds a trench and beer to coincidence as mentioned above, and is crowded is completed. Furthermore, a wiring process is completed by embedding the metal containing non-illustrated Cu or Cu from a trench and beer.

[0037] In addition, the relative etching capacity over each film of mixed gas used for etching is shown in drawing 6. O in drawing, \*\*, and x mean a medium and low \*\* with high etching capacity in order.

Although x does not have chemical etching capacity, there is physical etching capacity a little.

[0038] As stated above, by covering the 3rd hard surface mask blank to the 2nd hard surface mask blank for trench patterns, at the conventional process, the 1st and 2nd exposed hard surface mask blanks can be protected, and it can control that shoulder omission is made to both hard surface mask blanks.

Moreover, by having made the 3rd hard surface mask blank into two-layer structure, it can be in process, only the upper layer of the 3rd hard surface mask blank which shoulder omission produced can be removed, and the hard surface mask blank which does not have shoulder omission again can be expressed. These things are more effective when the effects of shoulder omission are large trench width of face of 0.18 micrometers, and about 0.13 micrometers or less of diameters of beer, if it is the former. In addition, since SiON which is the upper layer of the 3rd hard surface mask blank works also as an antireflection film, it is effective in a dimension being stabilized in the case of lithography.

[0039] in addition -- without it removes as a modification the SiON layer 216 which is the upper layer of the 3rd hard surface mask blank at the 5th process -- or -- a part -- removing -- the 6th process -- the residual SiON layer 216 -- the method of removing all with the lower layer Oxide layer 214 is also



considered. The 1st hard surface mask blank is seldom etched in the case of etching at the 6th process by leaving a part of SiON layer 216, and performing the 6th process. Therefore, in addition to the above-mentioned effectiveness, the effectiveness which controls the shoulder omission of the beer formed in the SiLKTM layer 206 is also acquired.

[0040] Below, the process which forms the dual pellet syn conformation concerning the gestalt of operation of the 2nd of this invention is explained using the etching system of drawing 1, referring to drawing 4 and drawing 5. The FSG layer 204 (500nm of thickness) as inorganic LowK film which constitutes a layer insulation membrane layer in the upper part of the SiN layer 202 (50nm of thickness) as a protective coat as shown in drawing 4 (a), On it, the SiLKTM layer 206 (400nm of thickness) as organic LowK film, further -- a trench -- and -- beer -- forming -- a sake -- a hard surface mask blank -- a layer -- \*\*\*\*\* -- the -- one -- a hard surface mask blank -- it is -- a place -- SiON -- a layer -- 308 (200nm of thickness) -- and -- a trench -- formation -- \*\* -- a pattern -- a configuration -- having -- a photoresist -- (-- PR --) -- a layer -- 212 -- forming -- having -- \*\*\*\*.

[0041] First, as shown in drawing 4 (b) (the 1st process), using the photoresist (PR) layer 212 for trenches, according to a predetermined lithography process, a part of SiON layer 308 which is the 1st hard surface mask blank is etched, and a trench pattern is formed. As etching conditions at this time, the flow rate of 500W, mixed-gas CH<sub>2</sub>F<sub>2</sub>, and N<sub>2</sub> and Ar is set to 20sccm(s), 100sccm, and 100sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 50mT(s) and an electrode, respectively, for example.

[0042] After carrying out ashing of the residual photoresist (PR) layer 214 and removing it, as shown in drawing 4 (c) (the 2nd process), the 2nd hard surface mask blank is covered to the trench pattern which consists of the 1st hard surface mask blank. With the gestalt of this operation, the 2nd hard surface mask blank is a thin film which consists of a SiON layer 316 (less than 10nm of thickness). Furthermore, as shown in drawing 4 (d), the photoresist (PR) layer 218 for beer formation is formed on it. Even if over etching of a part of 1st hard surface mask blank was carried out in the 1st process and the SiLKTM layer 206 is exposed, in this 2nd process, the exposed SiLKTM layer 206 can be again covered by covering the 2nd hard surface mask blank of the same ingredient as the 1st hard surface mask blank to the 1st hard surface mask blank. Therefore, there is an advantage that mixing of SiLK-Resist does not arise.

[0043] Next, as shown in drawing 4 (e) (the 3rd process), using the photoresist (PR) layer 218 for beer, according to a predetermined lithography process, the residual parts of the SiON layer 316 which is the 2nd hard surface mask blank, and the SiON layer 308 of the 1st hard surface mask blank are etched, and a beer pattern is formed.

[0044] And as shown in drawing 4 (f) (the 4th process), while etching beer into the SiLKTM layer 206 which is the organic LowK film using the hard surface mask blank for beer which consists of the 2nd hard surface mask blank and the 1st hard surface mask blank which were formed at the 3rd process, ashing of the photoresist (PR) layer 218 is carried out, and it is removed. As etching conditions at this time, the flow rate of 1000W and mixed gas N<sub>2</sub> and H<sub>2</sub> is set to 100sccm(s) and 300sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 100mT(s) and an electrode, respectively, for example. In this case, after the photoresist (PR) layer 218 is removed, shoulder omission may arise in the 2nd exposed hard surface mask blank by over etching.

[0045] Then, as shown in drawing 5 (a) (the 5th process), the SiON layer 316 of the 2nd hard surface mask blank which shoulder omission has produced is removed. At this process, with removal of the SiON layer 316 which is the 2nd hard surface mask blank, the beer pattern part of the SiON layer 308 which is the 1st hard surface mask blank is etched, and a trench pattern is formed.

[0046] Next, as shown in drawing 5 (b) (the 6th process), beer is formed in the FSG layer 204 as a beer pattern using the beer formed in the SiLKTM layer 206 which is the organic LowK film. As etching conditions at this time, the flow rate of 1500W, mixed-gas C<sub>4</sub>F<sub>8</sub>, and CO and Ar is set to 12sccm(s), 225sccm, and 400sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 45mT(s) and an electrode, respectively, for example.

[0047] Next, as shown in drawing 5 (c) (the 7th process), a trench pattern is formed in the SiLKTM layer 206 using the trench pattern of the SiON layer 308 which is the 1st hard surface mask blank.



[0048] Next, the SiN layer 202 is etched and beer is made to penetrate using the beer pattern of the FSG layer 204, as shown in drawing 5 (d). As etching conditions at this time, the flow rate of 500W, mixed-gas CH<sub>2</sub>F<sub>2</sub>, and O<sub>2</sub> and Ar is set to 20sccm(s), 20sccm, and 100sccm for the power which impresses the pressure ambient atmosphere of the processing interior of a room to 30mT(s) and an electrode, respectively, for example. The dual pellet syn conformation which builds a trench and beer to coincidence as mentioned above, and is crowded is completed. Furthermore, a wiring process is completed by embedding the metal containing non-illustrated Cu or Cu from a trench and beer.

[0049] As stated above, according to the gestalt of this operation, the 2nd hard surface mask blank is covered to the trench pattern of the 1st hard surface mask blank. Therefore, it can control that the 2nd hard surface mask blank works as a protective coat of the 1st hard surface mask blank, and shoulder omission produces it in the 1st hard surface mask blank to the middle of a process. This is more effective when the effects of shoulder omission are large trench width of face of 0.18 micrometers, and about 0.13 micrometers or less of diameters of beer, if it is the former. Moreover, even if over etching of a part of 1st hard surface mask blank is carried out and the SiLKTM layer 206 is exposed in the 1st process by using the 1st and 2nd hard surface mask blanks as the same ingredient, there is an advantage that mixing of SiLK-Resist does not arise. In addition, since SiON which is the 2nd hard surface mask blank works also as an antireflection film, it is effective in a dimension being stabilized in the case of lithography.

[0050] In addition, the following approaches are also considered as a modification. The SiON layer 316 of the 2nd hard surface mask blank is not removed at the 5th aforementioned process, and it leaves the SiON layer 316 also at the time of etching for beer formation of the FSG layer 204 in the 6th process. And the SiN layer 202 is etched and beer is made to penetrate. The SiON layer 316 is removed by isotropic etching after etching termination, etchback of an anisotropy is performed after that and the SiON layer 308 which remained in the trench section is removed. In this case, the phase where the SiON layer 308 remains etching of the SiN layer 202 of the lowest layer in the trench section -- it can carry out -- SiON -- SiLKTM -- SiN -- since the selection ratio which receives dirtily is high, there is an advantage that the shoulder omission of the beer puncturing upper part generated in the case of drawing 5 (c) to drawing 5 (d) in the aforementioned approach is stopped.

[0051] As mentioned above, although the gestalt of the suitable operation concerning the gestalt of this operation was explained referring to an accompanying drawing, this invention is not limited to this example. If it is this contractor, it will be clear that it can hit on an idea for various kinds of examples of modification or examples of correction in the criteria of the technical range indicated by the claim, and it will be understood as what naturally belongs to the technical range of this invention also about them.

[0052] For example, although the plasma etching system shown in drawing 1 as equipment for enforcing the etching approach concerning the gestalt of this operation was mentioned as the example and explained, this invention is not limited to this example. For example, it cannot be overemphasized that it is possible to apply the etching system using the various sources of the plasma other than an parallel monotonous mold etching system.

[0053] Moreover, in the gestalt of the above-mentioned implementation, although the example using FSG as inorganic LowK film was given and explained, using SiLKTM as organic LowK film, this invention is not limited to this example. As organic LowK film, it is applicable also to the Pori fluoride [ naphthalene ] polymer film, the maleimide benz-cyclo-butene polymer film, the poly perphloro cyclobutene AROMATIKKETERU film, the polyimide film, the poly allyl compound ether film, the parylene film, the hydrogenation diamond film, or polytetrafluoroethylene. Furthermore, it is applicable to divinyl siloxane benz-cyclo-butene polymer film, silica addition polyimide film, etc. with which permutation addition of a part of silica is carried out into the organic poly membrane.

[0054] Furthermore, in the gestalt of the 1st operation of the above, although SiON was mentioned as the example and explained as SiO<sub>2</sub> and the 2nd hard surface mask blank as the 1st hard surface mask blank as a mask layer formed on the organic LowK film, this invention is not limited to this example. As the mask layer formed on the organic LowK film, and the so-called hard surface mask blank As the 1st hard surface mask blank, in addition to silicon oxide (SiO<sub>2</sub>) A silicon nitride (SiN), Silicon carbide

(SiC), a porous silicon nitride, a silicon acid nitride (SiON), Besides insulator layers, such as aluminate RAIDO (AlN) or silica film, metal nitrides and titanium carbide film (TiC), such as titanium nitride RAIDO (TiN) and tantalum nitride RAIDO (TaN), can be used. However, when conductive nitrides, such as TiN film and TaN film, are used, after embedding copper from this wiring gutter and beer, it is necessary to remove a conductive nitride by the chemical machinery grinding method or the dry etching method. Moreover, an insulator layer, metal nitrides, such as titanium nitride RAIDO (TiN) and tantalum nitride RAIDO (TaN), and titanium carbide film (TiC), such as silicon oxide (SiO<sub>2</sub>), silicon nitride (SiN) porous silica film, and silicon carbide film, can be used as the 2nd hard surface mask blank in addition to SiON. It being important in selection of these hard surface mask blanks is that the ingredients of the 1st hard surface mask blank and the 2nd hard surface mask blank differ.

[0055] Furthermore, in the gestalt of two above-mentioned implementation, in the 7th process, although the case where the SiN layer 202 was made to penetrate beer was mentioned as the example and explained after forming a trench pattern in the SiLKTM layer 206, this invention is not limited to this example. A trench pattern may be formed in the SiLKTM layer 206 after making the SiN layer 202 penetrate beer previously. Moreover, etching conditions, thickness, etc. are not limited to the above-mentioned example.

[0056]

[Effect of the Invention] As explained above, according to the configuration concerning this invention, on the hard surface mask blank for the conventional trench formation, the hard surface mask blank of the thin film for protection is covered, and it removes behind at the time of dual pellet syn conformation formation. The effectiveness which controls that the hard surface mask blank for the conventional trench formation in process is exposed, and shoulder omission arises from this is acquired. Consequently, the shoulder of a hard surface mask blank is formed in the configuration near an ideal right angle, and can acquire desired wiring structure.

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[Translation done.]

## \* NOTICES \*

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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## CLAIMS

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[Claim(s)]

[Claim 1] It is the etching approach of the dual pellet syn conformation which is the etching approach of a dual pellet syn conformation using the LowK film of at least one or more layers, and the hard surface mask blank of at least one or more layers, and is characterized by forming at least one or more layers of dummy film which finally does not remain into structure on said hard surface mask blank in order to prevent shoulder omission.

[Claim 2] Said LowK film is the etching approach of the dual pellet syn conformation according to claim 1 characterized by being formed by two kinds of film and etching by respectively different gas.

[Claim 3] Said LowK film is the etching approach of the dual pellet syn conformation according to claim 2 characterized by for the bottom being the inorganic LowK film and the bottom being the organic LowK film.

[Claim 4] Said hard surface mask blank is the etching approach of a dual pellet syn conformation given in any 1 term of claims 1-3 characterized by considering as one layer.

[Claim 5] Said hard surface mask blank is the etching approach of a dual pellet syn conformation given in any 1 term of claims 1-3 characterized by considering as two-layer.

[Claim 6] At least one layer of said hard surface mask blank is the etching approach of the dual pellet syn conformation according to claim 4 or 5 characterized by including SiON.

[Claim 7] Said dummy film is the etching approach of a dual pellet syn conformation given in any 1 term of claims 1-5 characterized by including the film of the same ingredient as said hard surface mask blank.

[Claim 8] Said dummy layer is the etching approach of the dual pellet syn conformation according to claim 6 characterized by being referred to as SiON.

[Claim 9] The inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer, the 1st hard surface mask blank, and the 2nd hard surface mask blank are set as the etched object. the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer -- it is -- : -- according to a lithography process to the 2nd hard surface mask blank To said 3rd hard surface mask blank and said 1st hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 3rd hard surface mask blank to the trench pattern which consists of the 2nd hard surface mask blank of; above; according to a lithography process The 3rd process which forms a beer pattern; with the beer pattern which consists of said 3rd hard surface mask blank and said 1st hard surface mask blank The 4th process which forms beer in the organic LowK film, and the 5th process which removes a part of 3rd hard surface mask blank layer [ at least ] of; above; according to the same etching conditions, while removing the remainder of said 3rd hard surface mask blank layer The beer which formed the trench pattern in said 1st hard surface mask blank with the trench pattern which consists of said 2nd hard surface mask blank, and was further formed in said organic LowK film is used as a beer pattern. The 6th process which uses and forms beer in said inorganic LowK film; the etching approach of the dual pellet syn conformation characterized by consisting of the 7th

process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st and 2nd hard surface mask blanks, and;

[Claim 10] Said 3rd hard surface mask blank is the etching approach of the dual pellet syn conformation according to claim 9 characterized by having two or more layer structure.

[Claim 11] The etching approach of the dual pellet syn conformation according to claim 10 characterized by removing the upper layer of the 3rd hard surface mask blank, and removing the lower layer of the 3rd hard surface mask blank in said 6th process in said 5th process.

[Claim 12] It is the etching approach of the dual pellet syn conformation according to claim 11 which the upper layer of said 3rd hard surface mask blank consists of SiON, and is characterized by a lower layer consisting of Ox.

[Claim 13] The inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer, the 1st hard surface mask blank, and the 2nd hard surface mask blank are set as the etched object. the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer -- it is -- : -- according to a lithography process to the 2nd hard surface mask blank To said 3rd hard surface mask blank and said 1st hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 3rd hard surface mask blank to the trench pattern which consists of the 2nd hard surface mask blank of; above; according to a lithography process The 4th process which forms beer in the organic LowK film with the beer pattern which consists of the 3rd process which forms a beer pattern, the 3rd hard surface mask blank of; above, and said 1st hard surface mask blank; according to the same etching conditions While removing said 3rd hard surface mask blank layer, with the trench pattern which consists of said 2nd hard surface mask blank The beer which formed the trench pattern in said 1st hard surface mask blank, and was further formed in said organic LowK film is used as a beer pattern. The 5th process which uses and forms beer in said inorganic LowK film; the etching approach of the dual pellet syn conformation characterized by consisting of the 6th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st and 2nd hard surface mask blanks, and;

[Claim 14] Said 3rd hard surface mask blank is the etching approach of the dual pellet syn conformation according to claim 13 characterized by having two or more layer structure.

[Claim 15] The inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer, and the 1st hard surface mask blank are set as the etched object. It is the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer. To a part of 1st hard surface mask blank of :above according to a lithography process To the residual part of said 1st hard surface mask blank, and the 2nd hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 2nd hard surface mask blank to the trench pattern of the 1st hard surface mask blank of; above; according to a lithography process The 3rd process which forms a beer pattern, and the 4th process which forms beer in said organic LowK film with the beer pattern which consists of the 1st and 2nd hard surface mask blanks of; above; while removing said 2nd hard surface mask blank The 5th process which etches the trench pattern part of said 1st hard surface mask blank, and forms a trench pattern; The beer formed in said organic LowK film is used as a beer pattern. The 6th process which uses and forms beer in said inorganic LowK film; the etching approach of the dual pellet syn conformation characterized by consisting of the 7th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st hard surface mask blank, and;

[Claim 16] The inorganic LowK film and the organic LowK film by which the laminating was carried out one by one on the lower layer wiring layer, and the 1st hard surface mask blank are set as the etched object. It is the etching approach of a dual pellet syn conformation that beer is formed in said inorganic LowK membrane layer, and a trench is formed in said organic LowK membrane layer. To a part of 1st hard surface mask blank of :above according to a lithography process To the residual part of said 1st hard surface mask blank, and the 2nd hard surface mask blank, The 1st process which forms a trench pattern, and the 2nd process which covers the 2nd hard surface mask blank to the trench pattern of the

1st hard surface mask blank of; above; according to a lithography process The 3rd process which forms a beer pattern; with the beer pattern which consists of said 1st and 2nd hard surface mask blanks The 4th process which forms beer in said organic LowK film; The beer formed in said organic LowK film is used as a beer pattern. The 5th process which uses and forms beer in said inorganic LowK film, and the 6th process which removes the 2nd hard surface mask blank of; above; The trench pattern part of said 1st hard surface mask blank is etched. The 7th process which forms a trench pattern; the etching approach of the dual pellet syn conformation characterized by consisting of the 8th process which forms a trench in said organic LowK film with the trench pattern which consists of said 1st hard surface mask blank, and;

[Claim 17] Said 1st and 2nd hard surface mask blanks are the etching approaches of the dual pellet syn conformation according to claim 15 or 16 characterized by consisting of the same ingredient.

[Claim 18] Said ingredient is the etching approach of the dual pellet syn conformation according to claim 17 characterized by being SiON.

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[Translation done.]